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UNMANNED VANGUARD: LEVERAGING THE OPERATIONAL EFFECTIVENESS OF THE ISRAELI UNMANNED AIRCRAFT SYSTEM PROGRAM

by

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The last decade has seen the rise of the role of Unmanned Aircraft Systems (UAS) in militaries around the world. According to David Rodman's article, *Unmanned Aerial Vehicles in the service of the Israeli Air Force*, "in terms of technological sophistication of its UAS force, Israel is unquestionably well ahead of the pack. Only the United States (US) is in the same league."[1] This paper will show how the Israeli Air Force (IAF) UAS program's unrivaled operational effectiveness is born from their continuity between mission requirements, UAS development, and aircrew training. It will compare the Israeli Air Force's (IAF) UAS program to the United States Air Force (USAF) UAS program while it details Israel's relatively long history of UAV employment, advanced defense industry, ongoing mission requirements, superior crew training and high morale. Lastly, it will show how the USAF can learn from the IAF effectiveness in continuity and take steps to solidify their own UAS programs in the future. This paper will focus on both the IAF's and the USAF's largest medium altitude long endurance (MALE) UASs.

History

Compared to the US, who's turbulent UAS history has led to a disjointed environment that is limited by debates over mission requirements, inter-service rivalry over UAS development, and relatively low morale, Israel's UAS history has been relatively stable. Since the 1970's, Israel has taken steps to expand and improve the mission effectiveness of its UAS fleet. Overall, the Israelis have been pioneers in the UAS industry. Although Israel was not the first country to indigenously produce UASs, it was among the first to use UASs in combat operations. The United States used Lightning Bug and Buffalo Hunter drone aircraft during the Vietnam War in the 1960's and were the leaders in UAS technology in the late 1960's and early 1970's.[2] In fear that Egypt's surface-to-air missile systems would put the lives of aircrew at risk,

Israel took advantage of the US UAS technology and acquired Teledyne Ryan's long range UAS, the Firebee, from the Unites States. In July 1971, Israel received the first twelve Firebees and carried out the first operational flight in September in the area of the Suez Canal to aid in finding the location of a downed IAF plane. Also during this period, Israel acquired 27 of Northrop's small UAS, the Chukar, designed to draw enemy antiaircraft fire. [3]

During the Yom Kippur War, both the Chukar and the Firebee saw extensive action. During the war, Israel launched Chukars toward the Golan Heights, and made the Syrians believe that a large formation of combat planes were going to strike their antiaircraft positions.[4] The subsequent firing of Syrian antiaircraft weapons allowed the Israelis to identify their firing positions and eventually destroy them. During the war, Israel launched twenty-three Chukars and five did not return.[5] Israel used their Chukars mostly in the north and they used their Firebees on the Egyptian front in the south. During the 12 days of fighting, Firebees conducted 19 flights and 10 were either shot down or crashed. [6]

Following the Yom Kippur War, the Israeli operational UAS focus diverged from the US operational focus as the US concentrated its efforts on the Central Front in Europe. During this period, the Israelis began an effort to produce their own indigenous UASs focusing on their reconnaissance and security needs. The US Air Force UASs developed during the 1970s were designed to accomplish three missions in a major war in Europe against Warsaw Pact forces: 1) weapon delivery against heavily protected targets; 2) tactical electronic and optical reconnaissance (both high and low altitude); and 3) electronic combat (jamming and chaff dispensing).[7] In contrast, the Israeli's operational focus was on defensive security including EW and reconnaissance. The already proven capabilities of the Chukar in the EW realm allowed Israel to focus their UAS development on reconnaissance.

Six years after the Yom Kippur War, the Israelis developed their own UAS, the Israeli Aircraft Industry‟s (IAI) Scout. The Scout was an improvement over the Firebee and could perform reconnaissance by broadcasting pictures from a stabilized camera. The Scout saw its first combat activity during the Lebanon missile crisis in 1981. During the crisis, which served as a preview for the First Lebanon War, the Scout successfully broadcasted real-time pictures of the Syrian antiaircraft systems deployed in the area. [8] During the First Lebanon War, the Israelis used the Scout for intelligence collection including locating antiaircraft batteries and armored vehicles, conducting battle damage assessment (BDA), and locating fallen aircraft. Israel also used the Firebee and Chukar in the First Lebanon war, but with less operational success than the Scout.[9] Israel continued to use both the Firebee and the Chukar into the 1990s. The Chukar remained in the Israeli Air Force inventory until 1990 and the Firebee until 1996.[10]

During the late 1970's and into the 1980's, Israel overtook the US as the leader in the UAS industry. During this time, Israel developed and fielded the most capable reconnaissance UAS systems in the world. Israel developed small MALE UASs such as the Pioneer that could provide long duration reconnaissance in a low threat environment. In contrast, the US attempts to develop very large and complex UASs, such as the BGM-34C multi-mission UAS and the MR-UAV (Medium Range Unmanned Aerial Vehicle), failed due to budget cutbacks, cost overruns and competition with other systems. Instead of pursuing these UASs, the US eventually focused their acquisition efforts on cruise missiles, stealth, and standoff weapons. As a result, leading into The Gulf War the US did not have a reconnaissance UAS in its aircraft inventory. To fill this gap, the US purchased the Pioneer from Israel.

In 1988, Israel also developed the IAI Harpy UAS to combat hostile surface-to-air missiles (SAM) sites or other radar sites. IAI designed the Harpy as a loitering UAS that would

sit over the battlefield and search for electronic emissions from the SAM sites with its passive radar seeker. Once it found a site, the Harpy would lock on and use its high explosive warhead to destroy it. Unlike the Pioneer, the Harpy was fully autonomous and required little operator input.[11]

During the 1990's, Israel's UAS focus continued to be on reconnaissance and EW. In 1992, the IAF acquired the IAI Searcher UA and used it along with their Scout UASs to combat Hezbollah. In 2000, the IAF acquired IAI's Searcher 2 and the Elbit Systems Hermes 450, both of which could carry a larger payload and fly longer ranges than either the Scout or the Searcher.[12] These two aircraft became the workhorses of the IAFs counterterrorism efforts in Gaza, Lebanon and the West Bank during the 2000's. After providing valuable intelligence during The Second Intifada, the Scout was retired in April 2004. The growing demands for real time full motion video (FMV) and the availability of new technology led the IAF to replace their Searcher 2 aircraft with the IAI Heron in 2007. [13] In 2008, the IAF also began development and fielding of the IAI Heron TP, which is Israel's largest and most capable UAS. The IAF used the Hermes 450, Heron and Heron TP along with the MQ-1 Predator, acquired from the US, for tactical reconnaissance and strike missions against Hamas during Operation Cast Lead. [14] In 2010, Israel began to acquire the Elbit Systems Hermes 900 with an upgraded endurance and payload capability than the Hermes 450.[15] Also in 2008, the IAI began development of the Harpy 2 or Harop to eventually replace the Harpy. The Harop features improved EW sensors and warhead and incorporates the addition of an EO/IR sensor to the platform.[16]

Danny Israeli, director of business development at Elbit's UAS division, stated, "while Israel is already acquiring its third- and fourth-generation UASs, advanced European countries are only now having a second round of UAS procurement and the rest of the world are buying

their first."[17] The consistent operational focus on reconnaissance and EW along with the constant combat need from the 1990s to the 2000s allowed Israel to continually improve and mature their UAS systems. In contrast, the disjointedness of the US program kept the US from fielding a UAS in the 1980s. When they did finally field a system in 1995, the General Dynamics Predator, it was an immature prototype. Not by coincidence, the Predator's design was highly influenced by Israeli technology. It was actually a derivative of Israeli designer Abraham Karem‟s Amber project. Early operational assessments conducted by the Office of the Secretary of Defense (OSD) Director, Operational Test and Evaluation, determined Predator to be deficient in mission reliability, documentation, and pilot training support.[18] The Predator and its follow on the Reaper have become very successful combat proven aircraft, but these issues still plague the programs 17 years later.

Israeli Defense Industry

A large reason for the success of the IAF UAS program is the capability of the Israeli defense industry. According to those in the industry, Israel ranks second in the development and possession of UASs.[19] The success of the Israeli defense industry is significantly out of proportion to the size of the country. It exports the majority of what it produces and keeps the best for itself. According to Ministry of Defense Foreign Defense Assistance and Defense Export Department, Israel's total 2009 defense exports were in excess of $6.75 billion.[20] Its UAV exports are a significant portion of this amount. The Israeli Aerospace Industry (IAI) exports UASs to many different countries including India, Germany, France, United Kingdom, Turkey, and several Latin American countries.[21]

Israel's large defense export industry gives it access to funds and information sources that they normally would not have. They leveraged this access to develop some of the most capable

UAS's in the world. This combined with the small size of their IAF and the lack of bureaucracy allows them to develop and field UAS systems much faster than the USAF. Israel's mandatory draft and subsequent combat experience of its population helps the IAI develop products with a combat focus. The incorporation of reserve soldiers into the IAI helps bring a combat focus to the IAI systems and helps bridge the gap between engineer and operator.

Platforms

The IAF currently fields four medium range long-endurance (MALE) UASs: the Hermes 450, Hermes 900, Heron, and Heron TP. All four of these UAS systems are primarily designed to provide real-time full motion video for tactical reconnaissance, and can be modified to carry different payloads for electronic warfare or attack missions. The Hermes 450 is the smallest of their MALE UASs and is in between the US Shadow and MQ-1 Predator in size and capability. Both the Hermes 900 and Heron are larger than the Hermes 450 and similar in size and capability to the MQ-1 Predator. The Heron TP is the largest of Israel's UASs and compares in size to the US RQ-4 Global Hawk. All of the IAF MALE UASs feature an automatic takeoff and land system. The IAF also features the smaller Harpy and Harop UASs designed to suppress enemy SAM and radar sites.

The workhorse of the IAF‟s UAS program is the Hermes 450. Its high-wing monoplane design is often referred to as a "flying cigar" or "cigar with wings." It has a 34-foot wingspan, a max takeoff weight of 992 pounds, a max endurance of 20 hours, a maximum altitude of 18,000 feet and a cruising speed of 70 knots. It is capable of fully autonomous control with in-flight redirection capability. It is also capable of carrying 330 pounds worth of payload including an EO/IR camera with laser designator, SAR/GMTI, SIGINT, ELINT, or communications relay

pod. The IAF usually flies the Hermes 450 in line-of-sight (LOS) C-Band datalink, but is capable of flying it in beyond line-of-site (BLOS) SATCOM datalink operations.[22]

The Hermes 900 is an advanced version of the Hermes 450 that is double its size and resembles the size and shape of an MQ-1 Predator, but with the wing tails pointing up versus down with the Predator. It has a 49-foot wingspan, a max takeoff weight of 2,140 pounds, a max endurance of 40 hours, a maximum altitude of 33,000 feet and a cruising speed of 60 knots.[23] It can carry twice the payload of the Hermes 450 and has an onboard radio. It can be flown by either C-Band LOS datalink or BLOS SATCOM datalink. It is postulated that the Hermes 900 is capable of carrying small attack munitions, but the IAF keeps that information classified.[24]

Both the Hermes 450 and the Hermes 900 use the same Elbit ground control station. The Elbit ground control station allows for very simple aircraft control. Pilots control the direction of aircraft flight by pointing and clicking with a computer mouse. The ground control station also allows operators to slave the aircraft location to the targeting pod and the aircraft automatically flies in the best location to optimize the stability of the targeting pod. This greatly simplifies one of the most difficult tasks that USAF MQ-1 Predator pilots face. The Predator's Multispectral Targeting System (MTS) loses stability and goes NADIR when reaching depression angles below -80 degrees. In dynamic situations, such as moving vehicle follows, it is very common for the pilot to miss-position the aircraft causing the MTS to lose stability and subsequently lose the vehicle they were following. Both the Hermes 450 and Hermes 900 targeting systems also have a similar region of instability, but the aircraft autopilot system prevents the aircraft from flying to a position where it becomes a factor.[25]

The Heron UAS is similar in size to the Hermes 900. It is an all-weather aircraft with a 55-foot wingspan and maximum takeoff weight of 2,400 pounds. Its cruise speed is 125 knots

and it can fly at altitudes up to 30,000 feet, carry about 550 pounds of payload and has an endurance of more than 40 hours.[26] It is distinctively recognized by its twin-boom tail style, which is similar to the Vietnam era US OV-10 aircraft. Its open architecture enables the IAF to tailor its payload packages to meet many different mission requirements.[27] This payload mix includes day and night electro-optics, maritime patrol and synthetic aperture radars, communication relay equipment, electronics intelligence equipment and others.[28]

The Heron TP is the follow on to the Heron and is substantially larger. It is one of the most capable UASs in the world. It has an 85-foot wingspan and 10,000-pound maximum takeoff weight. It has a turbo-prop engine similar to the MQ-9 Reaper and can fly at altitudes up to 45,000 feet with a maximum endurance of 36 hours. Its one-ton payload is four times greater than the payload of the Heron. The Heron TP is capable of carrying weapons to fulfill the attack role, but the IAF has not confirmed this capability due to classification. It has an advanced all-weather capability distinguishing it from the USAF Predator and Reaper systems that cannot fly in adverse weather.[29]

The IAF uses the Advanced Common Ground Station (ACGS) to control both the Heron and the Heron TP. The ACGS is capable of controlling multiple aircraft simultaneously similar to the USAF multiple aircraft control (MAC) GCS used with the MQ-1 Predator.[30] The ACGS has many of the same human factors engineering advancements as the Elbit systems GCS used by the Hermes UASs. The next generation technology offers a big improvement on workload for the pilots and allows them to focus on their mission and payloads versus flying the aircraft.

Its engineers designed the controls for the younger generation who are more savvy with computers and mice. Pilots can just point and click to control the aircraft and concentrate the rest of their focus on mission requirements.[31]

In addition to their MALE reconnaissance UASs, the IAF also fields the IAI Harpy and Harop UASs. With wingspans between 2 and 3 meters, the Harpy and Harop are much smaller than the other UASs mentioned in this paper. What makes them relevant to the discussion is the significance of their mission. These small UASs are an example of the IAFs ability to field very mission specific UASs to support their mission requirements. The Harop provides valuable suppression of enemy air defenses (SEAD) support to the IAF. It can loiter for up to 6 hours to locate and destroy SAM or radar sites. The IAF uses a mission control shelter (MCS) to control the Harop. The "man in the loop" design allows an operator to determine whether to engage or abort an attack in real time.[32]

Current Missions

Constant internal conflict in Gaza and the West Bank along with very real external threats has made the IAF a very capable air force and their UASs are no exception. Unlike the US, the IAF does not use their UASs to project power across the globe. Instead, they use their UASs, which are much less expensive to operate than manned warplanes, for a variety of different localized missions including both counterterrorism and potential major combat operations against its neighbors. According to Anan Israeli, commander of an Israeli drone squadron, the cost per flight-hour of Israel's drone fleet is less than 5% the cost of its fighter jets.[33] The majority of UAS operations undertaken by the IAF are done over Israeli controlled territory and are within line of sight of their control stations.

The primary mission of the IAF's MALE UASs is to provide intelligence, surveillance, and reconnaissance (ISR) in support of its internal counterterrorism operations. The IAF uses their UASs for real-time reconnaissance including locating, tracking, and targeting of suspected or known terrorists and assisting ground troops with situational awareness during urban

operations. In addition, the IAF uses its UASs to assist the direction and delivery of smart weapons to counterterrorism targets. The UASs use sensors to detect a rocket launch and then talk IAF attack aircraft onto the target so they can destroy it.[34] The IAF also uses their UASs for real-time reconnaissance to protect key infrastructure. Both the Heron and the Heron TP perform the maritime patrol mission for the IAF. A good example of this is the IAF's use of Heron UASs to keep watch on Israel's disputed offshore gas fields in the eastern Mediterranean. After Hezbollah threatened to target Israel's energy facilities, the IAF began using their Heron UASs to perform maritime surveillance of the area.[35]

In addition to using their UASs in support of counterterrorism operations, Israel also uses their UASs in an external protection role. If major conflict arose between Israel and its neighbors, the IAF is capable of using its UASs for ISR, CAS, SEAD, and ballistic missile defense. To support these missions, the IAF has done a good job of enhancing the survivability of its UASs in a higher threat environment. The Heron TP is one of the first UAVs in the world to have survivability systems incorporated into its initial design.[36] In addition, most of the IAF UASs are capable of using homegrown electronic warfare suites with simple decoys for self-defense.[37] The Harpy and Harop UASs are designed for the contested environment and bring SEAD support to the rest of the IAF.

In the case of an Israeli conflict with Iran, both the Hermes 900 and the Heron TP systems could provide ISR or SEAD support. Both aircraft are capable of using beyond line of sight SATCOM datalinks to extend their range allowing them to reach Iran. In addition, the Heron TP features self-protection equipment giving them better survivability. Most likely, Israel would use these systems for target acquisition, post-strike BDA, and electronic warfare, but it is possible they could be armed and used for target prosecution as well.

The specific nature of the conflict they face and their defensive posture allows the IAF to establish a very good infrastructure for command and control of its UASs. The IAF flies the majority of their UAS operations within line of sight of the ground control stations, so there is less of a requirement for SATCOM operations. This simplifies the datalink requirements and allows the IAF to build a robust data dissemination system. It also simplifies their communication requirements allowing them to use ground based UHF and VHF radios vice using radio's onboard the aircraft. The close proximity between the aircrew in the ground control station and the aircraft they are flying also allows the IAF to better integrate their UASs into the mission. Instead of being geographically separated by thousands of miles, like the USAF UAS mission aircrews performing remote split operations, the IAF aircrew are very close to the fight. This allows them to have face-to-face interaction with the ground elements they are supporting which helps build trust and leads to better integration. UAS aircrew can take part in mission planning sessions and then step to fly the mission. The USAF remote split operations concept precludes this from happening, unless done through video teleconference.

Training

Like the US, the IAF has seen a rapid increase in demand for real-time full motion video on the battlefield and is attempting to find the best balance of quality versus quantity of UASs.[38] In fact, in the past two years the Israeli fleet of UASs has tripled in size.[39] The IAF is solving the problem by making their UASs highly automated and then streamlining their training pipeline to allow operators to concentrate on the mission versus aircraft systems. This allows the IAF UAS training programs to have a different focus than the USAF UAS training programs.

The level of automation of their UAS systems allows the IAF to have a different training focus than the US. Due to their underdeveloped prototype nature, the US systems have very

complex controls and are very difficult to operate in a dynamic environment. On the other hand, the level of automation of Israeli UASs makes operating the system much easier and allows crews to concentrate on the mission at hand. The US spends the majority of their training program teaching aircrew how to operate the complex system and very little of their program teaching the mission requirements. This is mostly due to the rapid fielding of the immature Predator system, which led to the fielding of a ground control station that lacks the human factor engineering seen in most USAF manned aircraft. An example of this is the location of the aircraft control stick and the radio push to talk button in the Predator ground control station (GCS). The control stick is on the right-hand side of the cockpit and the radio push to talk button is located on top of the control stick, but not in a location that the pilot can reach with a finger on their right hand. It is very common to see a Predator pilot using their right hand to maneuver the aircraft with the control stick, and have to reach across their body with their left hand to push the radio push to talk button on the same control stick. All while they are looking across the control station at the situational display screen to keep track of their aircraft maneuvers. This maneuver is complicated for the most advanced weapons instructor, let alone a brand new pilot with very little flying experience or air sense. This stands in stark contrast to many of the Israeli ground control stations where aircraft control is simplified allowing crews to focus on mission tasks. This allows IAF UAS aircrew to learn system operation very quickly so they can spend the majority of their training time on mission requirements and very little training time teaching aircrew how to operate the system.[40]

The disparity in complexity of systems also effects how the IAF and the USAF select their UAS crews. The stability of Israel's UAS programs from the 1970s to the 1990s not only allowed them to develop advanced systems, it also allowed them to determine the best avenue for

acquiring UAS pilots. The USAF UAS programs did not have this same stability and were rushing to field an immature prototype. As a result, the USAF decided it needed to use pilots to ensure the proper operation of such a complicated and large system. According to former Chief of Staff of the Air Force General Jumper, "The original notion of using pilots was because of the Army experience [with UASs]. We were trying to get the accident rate down and get the operator-accident rate down. We knew if we crashed a bunch of these things, that we weren't going to get [the predator UAS program] either. That's why we insisted on pilots." General Ronald R. Fogleman, who was Chief of Staff of the Air Force during this time, echoed this when he stated, “If Predator fails, it won’t be because of our pilots.”[41] One of the fallouts of this decision is the level of quality of the pilots that leaders initially selected to fill the USAF UAS career field. Fearful of losing their best pilots to the program and hurting their squadron or wings combat capability, most commanders sent their pilots that were capable of performing their mission, but had been outperformed by the peers.[42] This led to slow development during the initial years of the Predator program.

Free from the political turmoil that surrounded the USAF UAS program the IAF decided to use mostly non-rated aircrew to fly their UAS systems. Instead of using their pilot training pipeline to fill their UAS requirements, the majority of IAF operators are pilot training washouts or come from other career fields such as air traffic controllers. The only rated pilots are those that could not continue to fly manned aircraft due to medical problems.[43] This allowed them to keep their pilots in their primary career field for which they were trained.

In an attempt to follow suit with the IAF to increase the number of UAS aircrew the USAF recently began a program to cross-train officers from non-rated career fields into their Predator training. To determine possible candidates, the USAF bases their selection on the

Candidate's past job performance in an unrelated context, such as a candidate's officer training report from their job as a finance officer. It is not until after they are selected that they go through an initial flight-screening program, which is similar to the normal USAF undergraduate pilot training (UPT) process. [44]

This is different from the IAF, which bases their selection on a screening process that includes contextual tests to determine a candidates ability to perform simultaneous tasks like listen to the radio, reply to communications, and fly the UAS. These traits are similar to the intellectual capabilities of a pilot of high-performance aircraft, but without the emphasis on physical coordination.[45] While it is difficult to prove with certainty which strategy produces the best candidates for selection, the IAF strategy seems to be more logical.

Morale

The morale within the IAF UAS squadrons is very high. This is due in large part to the fact that their mission is one of survival. As opposed to USAF remote split operations where aircrew fly missions in Iraq or Afghanistan from the US and are completely separated from the conflict, IAF UAS aircrew find themselves directly in the middle of the fight. The rockets teams that they are attempting to locate and destroy, could be targeting their families or even the ground control stations they are sitting in. This is not to question the USAF UAS aircrew's professionalism or their commitment to the fight. It is just human nature that the closer you are to conflict, the more it affects your decision-making. In fact, many USAF UAS aircrew that deploy as part of the launch and recovery element admit that they have a higher level of motivation when they deploy and are close to the fight. The Israeli's do not need to deploy to the get close to the fight. It is already front and center and this helps make the IAF UAS aircrew extremely dedicated to the cause and highly motivated to achieve mission success.

Another reason for high morale within the IAF UAS squadrons is their aircrew selection process. As mentioned earlier, the IAF does not take pilots from their pilot training pipeline to man their UAS squadrons. Instead, they look to find individuals that are motivated to be a part of the UAS program. The USAF's use of pilots taken from other USAF aircraft and directly from the pilot training pipeline has resulted in many disenchanted aircrew who want to return to manned aircraft. This may be due to their love of flying, but it also might be due to their perceived drop in societal status within the Air Force when their membership to the fraternity of pilots is questioned.[46] This combined with the long hours and geographic separation makes for relatively low morale within the USAF UAS squadrons. In contrast, the high level of automation and the specific mission focus of IAF UASs give the IAF the flexibility to take non-rated personnel who are highly motivated to be UAS aircrew.

While most IAF UAS pilots will admit that flying a manned fighter aircraft is a much more prestigious occupation, they understand the importance of their mission and so do the IAFs leaders. In 1999, due to the increasing capabilities and the heavy workload of UAS operators, the IAF decided to give UAS operators the right to wear flight suites and UAS operator wings.[47] They followed up this decision by paying UAS operators the stipends enjoyed by their jet and helicopter counterparts.[48] Both measures greatly improved morale within their UAS squadrons.

Refocusing the USAF UAS Path

The USAF should take note of the IAF's continuity within its UAS program and take measures to improve the continuity within its own UAS programs. With the recent post Iraq drawdown and subsequent cutbacks, the USAF has shown a commitment to bolstering their UAS fleet. The recent USAF force structure changes show that while other counterinsurgent or small war focused aircraft, such as the AT-6 or MC-12, are being cut or moved to the National

Guard, the UAS fleet is continuing to grow and will make up the majority of the USAF small war capability in the future. In order to maximize the effectiveness of this capability the USAF needs to take a lesson from the Israeli's and refocus the continuity of their UAS program. With the end of operations in Iraq and as operations in Afghanistan drawdown, the USAF will finally have the breathing room to regain control of their UAS programs. The USAF should use this time to follow in the IAFs footsteps and align their aircraft design, aircrew training, and mission requirements.

In the last few years, there have been many instances of US defense contractors collaborating with IAI contractors to develop UAS systems. A good example of this interaction is the partnership between General Dynamics and Elbit to develop Hermes and Skylark systems for the US department of defense.[49] Another example is General Dynamics partnering with Simlat to develop UAS simulation training.[50] Both of these show how the US can leverage IAI's advanced UAS industry. The USAF should expand their incorporation of IAI's innovation and begin to work IAI ideas into programs such as the MQ-9 Reaper advanced cockpit. The IAI's expertise in automation would aid design of the new cockpit. The new design should allow minimal system interaction during simple ISR missions while at the same time simplifying system interaction for more advanced strike missions.

In addition to learning from Israel's innovation and expertise, the USAF should also learn from Israel's aircrew training program. Unlike the clear continuity between the IAF UAS program's aircrew training and mission requirements, the USAF UAS programs are very disjointed. The current USAF UAS aircrew-training program is all over the map on approaches to solving its manning problem. The USAF is currently struggling to determine whether to pursue a quality or quantity path with their UAS programs. This problem originated with the

original fielding of the Predator system and the decision to use rated aircrew from other platforms to pilot the system. The rush to field the prototype aircraft prevented incorporation of a higher level of human factor engineering and automation into the system. Staffing the program with sub-optimal disgruntled pilots further delayed implementation of improvements to the system. As a result, the community was unprepared for the rapid increase in demand that they have experienced during operations in Iraq and Afghanistan. The rapid growth made advancements to the aircraft very difficult because engineering efforts focused on increases in production versus system improvement. The rapid growth also led to a pilot shortage, because not enough manned pilots were available to go through the training pipeline. When AF leaders decided to start using non-rated pilots to help alleviate the pilot shortage, the high operations tempo made it difficult to determine the best way to incorporate them into the system. As a result, instead of having a training program that matches the capabilities they need to fill mission requirements like the IAF, they have a mix of under-qualified and over-qualified pilots.

The IAF has specifically designed systems with enough automation to allow non-rated pilots to accomplish the mission and then subsequently manned their units with non-rated pilots. The USAF has taken a substantially different path. They developed a system that is fairly complicated and then manned it with rated aircrew from other manned USAF platforms, new rated aircrew directly from UPT, and non-rated aircrew from other career fields. While there are slight variations in their training during RTU and MQT, once they reach their operational squadrons these aircrew all perform the same mission despite their background and experience. The system does little to capitalize on experience of the crews from other platforms, or the high morale of the non-rated aircrew. For the most part, all crews perform the same missions despite

capability level. In many cases, this leaves rated aircrew unfulfilled and non-rated aircrew over tasked.

Both the IAF and USAF have seen the mission set of their UASs grow as their UASs have become more and more capable. Because of their relatively small size and relatively limited operations set, the IAF has been able to adapt to the increased demands that their missions require. The USAF UAS programs on the other hand, have taken-on a greater number of missions and have had difficulty adapting. This has resulted in a growing discontinuity in mission focus. The gap in mission requirements between ISR and attack missions has widened with incorporation of systems such as Gorgon Stare that require removal of weaponry to prosecute.[51] The advent of these systems made many of the attack mission related skills not needed. There is no need to train a pilot in the complex advanced missions such as CAS or SCAR. Instead, the pilot just needs to know basic pilot skills such as airspace management, communications, and weather interpretation. As the USAF grows its UAS fleet and develops more of these ISR systems, they are flying a substantial number of missions in support of them. Despite this fact, the USAF still trains all of its pilots to perform all of the missions including the advanced mission tasks.

By looking at both the training and mission discontinuities together, a possible solution emerges. Instead of training all pilots to do all missions, the USAF should take steps to split their UAS units into ISR and attack or multi-mission squadrons. This would bring continuity to USAF UAS program and give it a clearer mission focus. In this regard, they would more closely mirror the IAF units. Creating "ISR only" squadrons and manning them with non-rated pilots will help solve the huge ISR demand needed in counterinsurgencies and small wars. The pipeline will be quicker and less expensive than pulling rated pilots from other platforms or

UPT.[52] It would capitalize on the morale of the non-rated aircrew or less experienced aircrew allowing them to fly the less demanding missions such as basic ISR, SIGINT or Gorgon Stare missions.

The remaining "multi-mission" squadrons would be manned with more experienced and capable rated pilots. These squadrons would fulfill the more complicated CAS, SCAR and advanced ISR taskings. This would allow these squadrons to focus on more demanding tasks leveraging their experience and giving them a higher level of satisfaction. The capabilities demonstrated by the 26th Weapons Squadron at the USAF Weapons School, show the high level of CAS and SCAR mission effectiveness that USAF UAS are capable of given experienced and trained aircrew. Unfortunately, because of lack of training and experience, the operational units cannot attain this level. Creating a dedicated squadron focused on these missions will help focus training and improve the overall UAS mission effectiveness. Separating the mission and training requirements into ISR only and multi-mission will bring continuity back to the USAF UAS programs by capitalizing on the strengths of the different manning pipelines. The USAF will follow the lead of the IAF and align its training programs with its mission requirements.

Summary

Despite its size, Israel has developed a UAS program that is one of the best in the world. The IAF‟s ability to focus its UAS development efforts and aircrew training to meet its ongoing mission requirements forms the basis of its operational effectiveness. Israel's combative past, combined with its excellent defense industry helped it continually improve its UAS programs over the last 40 years. Their ability to continually develop and field UASs at a time when the USAF was having difficulty with funding and mission requirements has helped lead them to be almost a generation ahead of the USAF in current UAS development and production. Another

crucial factor to the IAF's success has been the performance of the IAI export program. The IAI export program has given the IAF access to funding and technology that they most likely would not have produced on their own. As result, the IAF has fielded highly automated systems that allow non-rated aircrew pilots to operate them. The use of non-rated pilots and excellent training programs has led to increased morale within the IAF UAS squadrons.

All of these factors have made the IAF UAS program a model that the USAF should try to follow. The USAF should take measures to realign their UAS development and aircrew training to match their mission requirements. The current USAF UAS mission requirements have gotten too large to fill with their current squadron alignment. The investment the USAF has made in its UAV program amidst the current budget cuts and subsequent force restructuring has put an emphasis on the effectiveness of its UAV fleet. One way to get a better return on their investment is to split the mission of focus of its UAV squadrons to more closely mirror the IAF model.

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